Letter Health Consultation

HEALTH CONCERNS REGARDING BROMINE EXPOSURES AND ASSESSMENT OF CITY OF NAMPA PUBLIC WATER SYSTEM DISINFECTION BYPRODUCTS

Nampa, Canyon County, Idaho

July 19, 2016

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry

Division of Community Health Investigations
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

A health consultation is a verbal or written response to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members.

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You may contact the Environmental Health Education and Assessment Program, Idaho Department of Health and Welfare

208-334-5682

LETTER HEALTH CONSULTATION

HEALTH CONCERNS REGARDING BROMINE EXPOSURES

NAMPA, CANYON COUNTY, IDAHO

Prepared By:

Environmental Health Education and Assessment Program
Bureau of Community and Environmental Health
Idaho Department of Health and Welfare
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

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July 19, 2016

Rob Howarth, Division Director
Community and Environmental Health
Central District Health Department
707 N. Armstrong Place Boise, ID 83704

Dear Mr. Howarth,
Thank you for your recent referral of an Idaho resident's inquiry regarding potential bromine exposures. Specifically, the resident has inquiries regarding:

- Health impacts of bromine exposures.
- Bromine concentrations in the City of Nampa, ID public water system.
- Contact information for analytical laboratories that will perform bromine tests for domestic water as well as laboratories that will perform biomarker (blood/urine) analysis for bromine.
- Information regarding the medical condition, Factor V Leiden, and bromine exposure.

In response, the Environmental Health Education and Assessment Program (EHEAP), within the Bureau of Community and Environmental Health, in the Idaho Department of Health and Welfare, has prepared this Letter of Health Consultation to address the inquiry.

Bromine exposures
It is important to understand how elemental bromine interacts with the environment. Bromine is the term for the uncharged diatomic state of the element. This means that two bromine atoms are linked together in the elemental form (denoted as Br_2). Elemental bromine exists as a liquid that evaporates quickly at standard temperature and air pressure (32ºF/0ºC and 1 atmosphere, respectively).
Elemental bromine exposures will not occur outside of a manufacturing facility. Should bromine enter the environment accidently (such as during a spill), bromine will evaporate rapidly into the air and react with hydroxyl radicals to form hypobromous acid (HOBr) and the free bromide radical (Wexler, 2014).

Bromide exposures
Ionic bromide, the negatively charged anion of bromine, is found widely throughout our environment. Bromide ions are formed after chemicals containing bromine begin to degrade. In

the soil, bromide ions are stable and very mobile. Bromide adheres to soil very poorly and will move easily with water molecules. Food plants may take up bromide from soils (Flury and Papritz, 1993).

Historically, the use of the pesticide methyl bromide (MeBr) was a source of environmental bromide exposures. While MeBr is quite toxic to humans, it evaporates readily and degrades rapidly (ATSDR, 1992). As MeBr has been identified as an ozone-depleting chemical, EPA phased out the use of MeBr as of January 1, 2005. There are certain EPA-approved critical uses of MeBr, such as quarantine and pre-shipment use, which are exempt from the phase-out (EPA, 2016a).

Bromide itself is of very low toxicity (Flury and Papritz, 1993; van Leeuwen, et al., 1987). Indeed, neither the Agency for Toxic Substances and Disease Registry (ATSDR), nor the U.S. Environmental Protection Agency (EPA) have established any health or risk-based standards for exposures to ionic bromide in the environment (ATSDR, 2016; EPA, 2016b). In the past, bromide was used in the treatment of epileptic disorders and as a sedative, though the development of more effective and specific pharmaceuticals has made this use of bromide obsolete. Symptoms of elevated exposures to bromide include nausea, vomiting, drowsiness, loss of emotional control, loss of memory, poor motor coordination, and in some cases an acne-like rash on the skin (van Leeuwen, et al., 1987).

When bromide ions enter water, they are likely to react with other chemicals also in the water. In chlorine-treated water supplies, bromide ions will form disinfection byproducts (DBPs). Two such byproducts are bromoacetic acid and dibromoacetic acid. These compounds are not identified as carcinogens (ATSDR, 2016). When treated water is sampled to determine if any harmful contaminants are present, bromo-and dibromoacetic acid and three other haloacetic acids (together called the HAA5) are grouped together for testing. Bromide ions in a chlorine-treated water supply can also form trihalomethanes (THMs). The most common THMs are dibromochloromethane, bromoform, chloroform, and bromodichloromethane. Of these, chloroform and bromodichloromethane are considered *possibly* carcinogenic to humans (ATSDR 1987, 1997, 2005). The U.S. EPA has established maximum contaminant levels (MCLs) for both the HAA5 and THMs. When public water systems are tested, the established EPA MCLs (60 ppb HAA5, 80 ppb THMs; EPA, 2016c) are compared to the total water concentration of each DBP group. See **Table A1**.

In a public water system that is disinfected using ozone, bromide ions may combine with ozone to form bromate. Bromate is a potential carcinogen. Bromate can also form when bromide is present in chlorine-treated waters that are exposed to the sun for prolonged periods of time. The Nampa municipal water system does not use ozone disinfection techniques, nor does it use open-air treated water reservoirs, therefore, bromate exposures are not a concern for this system.

Analytical testing data from City of Nampa public water system

The water system in question, the City of Nampa, ID public water system, does not test for general bromide content, but as it is treated using chlorine disinfection, it is routinely sampled for the those bromide containing DBPs mentioned above. For this report, I reviewed all DBP analytical data for the City of Nampa public water system from calendar year 2014 until the most

recently available. DBPs are tested for in drinking water at four locations per quarter, a total of 36 reports were reviewed for this document. These data sets are available upon public request by filling out the form found at this website address: http://www.deq.idaho.gov/contact-us/public-records-request/. Furthermore, DBP and other monitoring results can be found at the Idaho Dept. of Environmental Quality's Public Water Switchboard at: http://dww.deq.idaho.gov/IDPDWW/

The City of Nampa public water system is tested for DBPs at four locations deemed most likely to contain indications of DBP contamination due to the water pipe system configuration. These sites are listed as: Dooley Ave, Middleton Rd, Tanner Pl, and Burlington Dr. Please see the attached map (**Figure B1)** indicating the locations of each testing site. Of these 36 reports reviewed, there were **no exceedances** of the MCL for either HAA5s or THMs. During this time period, there were two (2) detections of HAA5 chemicals, both roughly 1/60th of the MCL. There were sixteen (16) detections of THMs, ranging from 1/20th to 1/10th of the MCL (**Table A1**).

Non-cancer health effects: As there are no exceedances of established EPA MCLs (**Table A1**), no adverse non-cancer health effects are expected for all uses (domestic, culinary, etc.) of City of Nampa public water system.

Cancer health effects: Though there were no exceedances of MCLs, sampling data indicates potential intermittent exceedances of cancer risk evaluation guideline values (CREGs) for dichloroacetic acid, trichloroacetic acid, bromodichloromethane, bromoform, and dibromochloromethane (**Table A1**). As the HAA5s and THMs are grouped together (and not separated by analyte) in the analytical reporting, it is impossible to determine the true individual concentration of any of the above mentioned DBPs. Although ATSDR has developed CREG values for the DBPs mentioned, it is important to note that none of these chemicals are classified as *known human carcinogens* by the International Agency for Research on Cancer (IARC; **Table A1)**. IARC classification of 2B (possible human carcinogen) and 3 (not classifiable as to carcinogenicity), indicates that the existing data are, at best, suggestive that these chemicals are carcinogenic to humans (IARC, 2006). Therefore, since none of these chemicals have exceeded the established EPA MCLs for public water systems in the last two years, and that their detection in the water system is only intermittent, and that the cancer-causing potential of these chemicals in humans is established as suggestive at best by the IARC, it is the position of EHEAP that cancer risk associated with exposures to these DBPs in the City of Nampa public water system is too low to be considered a health concern.

Analytical testing available for bromide contamination

Drinking water: There are several local analytical laboratories that will perform bromide testing on water samples. As the State of Idaho cannot recommend one private business over another, please find a list of certified drinking water laboratories on this Idaho Dept. of Health and Welfare web site:
http://www.healthandwelfare.idaho.gov/Health/Labs/CertificationDrinkingWaterLabs/tabid/1833/Default.aspx

Biomarker testing (blood and urine): The half-life (amount of time required for the human body to clear half its current level of bromide) is roughly 12 days (ATSDR, 1992). One can determine the amount of bromide exposure through urine or blood testing. There are several laboratory testing facilities that will carry out bromide urine/blood tests in the Boise area. Two such firms

are LabCorp and Treasure Valley Lab. The contact information for both of these businesses is available readily through the internet. The State of Idaho does not promote any private industry above another.
Note: Bromide is normally present in blood, but the level would be higher if there are recent exposures to a contamination source. These tests are not routinely performed at doctors' offices, but a doctor can take blood or urine samples and send them to a testing laboratory. These testing laboratories will provide the physician with instructions regarding the proper procedures for preparing and shipping the sample to the laboratory. Laboratories can also provide information regarding the interpretation of bromide urine/blood results.

Factor V Leiden and bromide exposures
Factor V Leiden (FVL) is a genetic mutation that arose an estimated 21,000 years ago. Individuals inherit this mutation from their parents. Though relatively rare in the world-wide population, up to 5% of European Caucasians carry the mutated gene. Certain behaviors/conditions may increase the likelihood of experiencing health effects due to FVL, for example, use of oral contraceptives, pregnancy, increasing age, vitamin B-deficient diets, and smoking (Van Cott et al., 2016). A search of the peer-reviewed medical and toxicological literature via Pubmed and Toxnet, respectively, did not reveal any linkage between bromide exposures and FVL-related health effects.

CONCLUSIONS AND RECOMMENDATIONS

- Non-occupational bromine exposures are extremely unlikely to occur due to the chemical nature of bromine.
- Hazardous exposures to bromide in residential settings are most likely limited to DBPs in public water systems.
- Based on an evaluation of the available water sampling data from January 2014 to April 2016, the EHEAP concludes that DBP bromide exposures associated with the City of Nampa public water system will not result in adverse health effects.
- Testing for bromide in residential tap water is available locally. Though this public water system does not test for bromide, the very low levels of DBPs suggest that bromide levels in this water system are also very low. Based upon the available data and literature, the EHEAP does not recommend the need for further drinking water sampling from residential taps.
- Biological exposure testing is available locally. Unless another current bromide source is identified in this area, the drinking water data and the short half-life of bromide in the human body does not support the need for biological exposure testing.
- There is no evidence that exposures to bromide containing chemicals affect FVL-related health effects. EHEAP does recommend that consultation with a physician is the most effective means to responsibly manage the health effects associated with FVL.

Should biological exposure testing be performed and results indicate elevated body-bromide, identification of the contaminant source will be warranted. EHEAP can provide information and referrals to resources to assist in the interpretation of that data if needed.

If you have any questions regarding this report, please contact Dr. Craig J. Dietrich at (208) 334-5682 or by email at dietrich@dhw.idaho.gov.

Sincerely,
Craig J. Dietrich, Ph.D., DABT
State Health Toxicologist
Environmental Health Education and Assessment Program
Idaho Dept. of Health and Welfare

cc:
Brian Crawford
Jerri Henry

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APPENDIX A: DATA TABLES

Table A1: DBP sample results for City of Nampa public water system

Chemicals of Concern	Test Results Range (ppb)	Residential Exposure Guidelines, Standards & Classifications			
		ATSDR Chronic EMEG[a] Child (ppb)	ATSDR CREG[a] (ppb)	EPA MCL[b] (ppb)	IARC Cancer Classification[a]
Haloacetic Acids					
Bromoacetic acid		-	NA		NC
Chloroacetic acid		-	NA		NC
Dibromoacetic acid		-	NA		NC
Dichloroacetic acid		-	0.7		2B
Trichloroacetic acid		-	0.5		3
Total Haloacetic Acids	ND-1.3			60[c]	
Trihalomethanes					
Bromodichloromethane		200	0.56		2B
Bromoform		200	4.4		3
Chloroform		100	NA		2B
Dibromochloromethane		900	0.42		3
Total Trihalomethanes	ND-7.9			80[d]	

[a](ATSDR, 2016)
[b](EPA, 2016c)
[c] MCL is for total of the five haloacetic acids
[d] MCL is for the total of the four trihalomethanes

Key

:	**Results value exceeds guideline or standard**
ppb:	**parts per billion, equivalent to µg/L**
EMEG:	**ATSDR Environmental Media Evaluation Guideline**
CREG:	**ATSDR Cancer Risk Evaluation Guideline**
MCL:	**EPA Maximum Contaminant Level**
-:	**A value is not developed for this chemical**
NA:	**A value is Not Applicable for this chemical because it is not a known or suspected carcinogen**
NC:	**The chemical is not classified by the IARC**
ND:	**Chemical not detected**
IARC 2B:	**Possible human carcinogen**
IARC 3:	**Not classifiable as to its carcinogenicity to humans. Evidence of carcinogenicity is inadequate in humans and inadequate in animals to warrant the classification as a carcinogen.**

APPENDIX B: MAPS AND FIGURES

Figure B1. Map of disinfection byproduct (DBP) testing locations in Nampa, ID. Locations provided by Idaho Department of Environmental Quality Regional Office.